A Practical Approach of Planning and Optimization for Efficient Usage of GSM Network

U S Rahman[1], M. A. Matin[2], M R Rahman[1]

[1]Department of Electrical Engineering and Computer Science, North South University, Bangladesh

[2] Department of Electrical and Electronic Engineering, Institut Teknologi Brunei, Brunei Darussalam

[*1]rashedur@northsouth.edu; [2]m.a.matin@ieee.org

Abstract

Planning of wireless networks is vital if operators wish to make full use of the existing investments. This paper deals with a practical approach of radio network planning process for efficient usage of GSM network. The key performance indicator (KPI) and drive test report of a Bangladeshi operator "Teletalk Bangladesh Limited" are used to make proposals on how operators can optimize radio resources as well as provide the required QoS to the subscribers. This study would help to plan operators to enhance coverage, improve quality and increase capacity in the days to come.

Keywords

Radio Network Planning; Qos; Optimization Tools; KPI

Introduction

Global system for mobile communication (GSM) standard for digital cellular communication was introduced in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system. GSM Network is comprised of a mobile Station (MS) which is connected to the Base Transceiver Station (BTS) via air interface. In addition to other hardware, BTS contains the equipment called Transceiver (TRx), which is responsible for the transmission and reception of several radio frequency (RF) signals to/from the end user. BTS is then connected to the base station controller (BSC) via abis interface. BSC usually handles radio resource management and handovers of the calls from one BTS (or cell/sector) to the other BTS (or cell/sector) equipped in it. BSC is then connected to Mobile Switching Centre (MSC) [1].

The performance of GSM network is mainly based on radio network planning and optimization. Due to increasing subscribers, the changing environments, rapid network expansion exceeding initial projections, capacity limitations due to lack of frequency resources and subscribers mobility profile changing, we need a continuous radio network planning (RNP) and Optimization process that is required as the network evolves. The RNP procedure involves among others coverage and interference analysis, traffic calculations, frequency planning, and cell parameter definitions.

Network optimization is a tradeoff between quality, traffic/revenues and investments. Without fine-tuned network the customer complaints and work load are increased and marketing becomes inefficient. The planning and optimization tools will assist the planner. However, all GSM operators find problems which are solved through KPI and drive test analysis. This paper addresses few problems and provides the solutions of these problems. The following parameters such as coverage, capacity, quality and cost for planning are considered during planning and optimization process.

Radio Network Planning and Optimization

The radio network planning and optimization is usually a comparative process and requires an initial baseline of KPI's and objectives. These can be derived from operator's individual design guidelines, service requirements, customer expectation, market benchmarks and others. Networks must be dimensioned to support user demands.

RNP and optimization process play a very significant and vital role in optimizing an operational network to meet the ever-increasing demands from the customers. Coverage is the most important quality determining parameter in a radio network. A system with good coverage will always be superior to a system with less good coverage. An area is referred to as being covered if the signal strength received by an MS in that area is

higher than a certain minimum value. A typical value in this case is around -95dBm. However, coverage in a two-way radio communication system is determined by the weakest link.

A link budget must be compiled before start of the dimensioning of the radio network. In the link budget, different design criteria for coverage (e.g. outdoor, indoor, in-car) is determined. In addition to this, factors such as receiver sensitivity and different margins are considered. Power budget implies that the coverage of the downlink is equal to the coverage of the uplink. The power budget shows whether the uplink or the downlink is the weak link. When the downlink is stronger, the EIRP used in the prediction should be based on the balanced BTS output power. When the uplink is stronger, the maximum BTS output power is used instead. Practice indicates that in cases where the downlink is the stronger it is advantageous to have a somewhat (2-3 dB) higher base EIRP than the one strictly calculated from power balance considerations [5], [6].

Defining the radio network parameters is the final step in the design of a radio network. There are a number of parameters that has to be specified for each cell. The parameters could be divided into four different categories, which are:

- Common cell data

  Example: Cell Identity, Power setting, Channel numbers

- Neighboring cell relation data

  Example: Neighboring Cell relation, Hysteresis, Offset

- Locating and idle mode behavior

  Example: Paging properties, Signal strength criteria, Quality thresholds

- Feature control parameters

  Example: Settings to control the behavior of e.g. Frequency Hopping and Dynamic Power Control [7].

Under normal circumstances, careful planning of wireless networks is vital if operators wish to make full use of existing investments. The optimization process has to produce alternative designs that fit according to the operator's planning goals depending on parameter settings. The traffic projection figures are vital for planners as it is used to denote the volume and nature of traffic processed by network nodes. The volume of traffic received determines the number of nodes used and capacity provisioned between nodes, whilst the nature of traffic has a bearing on the type of nodes deployed as well as allowing the planner to forecast traffic trends.

Radio Network Optimization Process

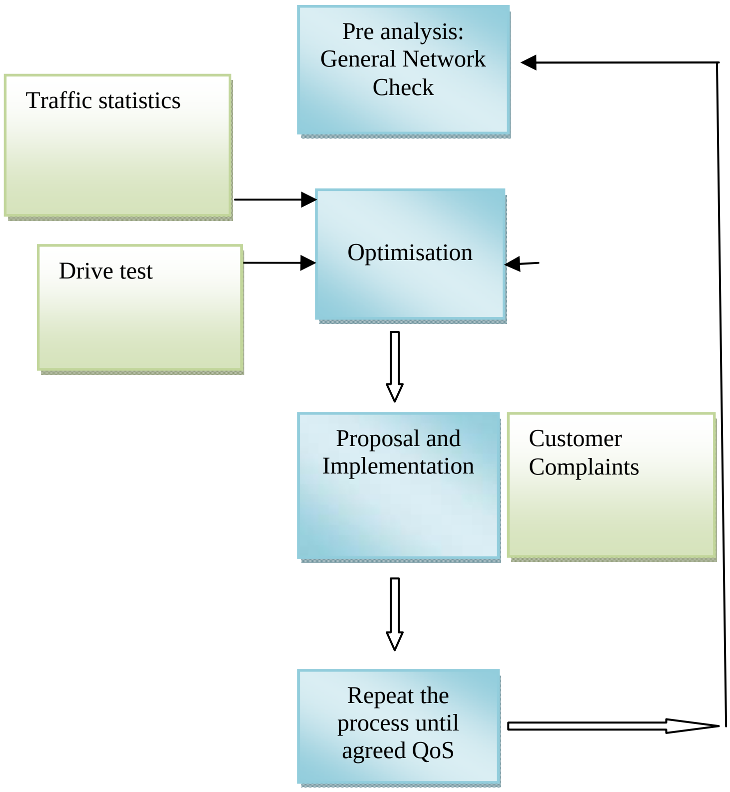

FIG. 1 RN OPTIMIZATION PROCESS

To determine projected growth in traffic, several factors are involved such as population types, incomes, distribution of wealth, taxation and spending habits. There is also a need for statistics depicting the existing penetration of mobile voice services and average Internet usage in the market.

Pre-analysis: General Network Check Steps to be carried out:

- Determine original network planning objectives and operators planning goals
- Collect information about network status
- Determine functional network structure, e.g.
  - BTS / BSC locations. Antenna direction/ azimuth, tilting etc.
  - services and features used
  - Network structure (macro cell, microcell etc.)

- Determine the network element configuration, e.g.
    - number of TRX per cell
    - sector / Omni configuration
- Visit selected sites
- KPI analysis

Customer Complaints Analysis

Quality targets:

- The customer's quality expectations are very simple:
    - Availability of the service anywhere, anytime
    - Call setup time within limits
    - Good speech quality during the call
    - Normal termination of the call
- Quality problems are indicated by:
    - Poor signal levels
    - High blocking rates
    - High bit error rates
    - Dropped calls/handover failures

Collect / Analyze OMC Statistics or KPI Analysis

OMC Measurement

- Handled traffic (congestion on TCH, SDCCH)
- dropped calls
- Interference
- Handover reason (due to UL_QUAL, Power budget, distance…)

Collect / Analyze Drive Test Measurements

Test Measurement

- Collect MS measurement report data (Downlink only!!)
    - BER (RXQUAL)
    - Serving signal level
    - Channel Number
    - CI and LAI
    - Timing Advance
    - BSICs
    - Signal and power levels of neighboring cells

Propose / Implement Changes

- Changes requested using standard forms
- Proper approval necessary (signatures)
- Physical change requests
    - Change antenna direction, tilt, height etc.
- Database change requests
    - Change frequency, add neighbour etc.
- All involved parties must be informed [8].

Drive Test for Finding Problem and Solution (Practical Cases)

1) Case 01:

Report type: Customer complain

Customer Address: House# B 57, Lalkuthi, Mazar Road, Mirpur-1

CB- Lalkuthi-4, Cell: 01552302440

Site ID: Lalkhuti

Area: Mirpur

BSC: DK06

Complain type: Bad noise, call dropping continuously, poor sound quality.

We got all green signals without one red signal in the house it means it had good RXlevel. In Fig.2, it is seen in the red circle area Mirpur _1E-3 created interference with 14 ARFCN when at the same time other site Bagbari _1 was serving to the customer house with same ARFCN 14. Right side of the snapshot we can see CI is 3.40 dB which is under 10dB and RXQuality is also bad.

Problem: Fig. 2 shows that interference creating between Bagbari_1 TCH (14) and Mirpur 1E_3 BCCH (14). Mirpur 1E situated at the 3rd circle and it GSM height is 32m. Due to excess height of Mirpur 1E overshooting between Bagbari_1 TCH (14) and Mirpur 1E_3 BCCH (14) which creating interference at encircle area.

Recommendation: Work order is issued to reduce GSM height of Mirpur 1E so no need to change frequency at Mirpur 1E_3 BCCH (14).

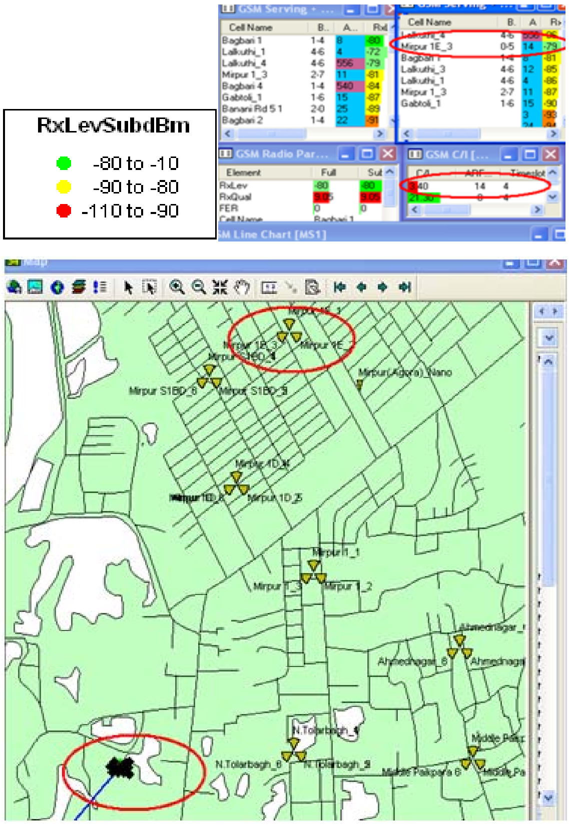

FIG. 2 SNAPSHOT OF DT

2) *Case 02:*

Report type: Customer complains.

Complain type: Bad noise, call dropping continuously, poor sound quality

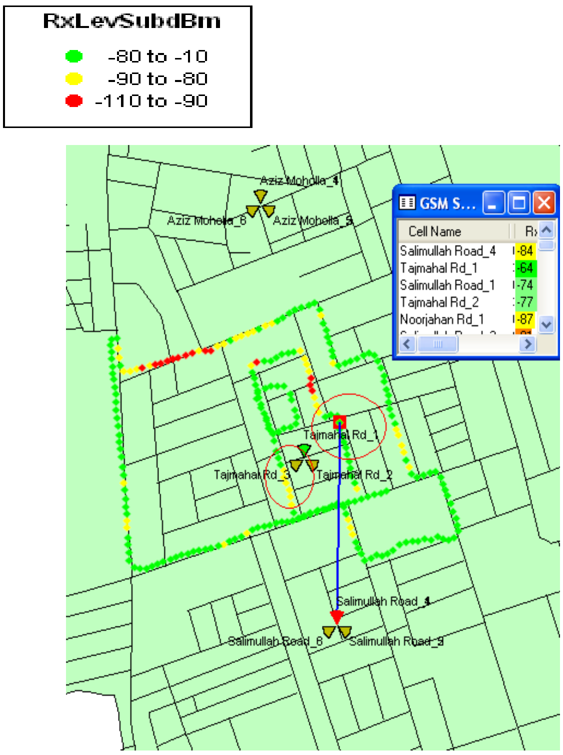

FIG. 3 SNAPSHOT OF DT

Fig.3 shows 3 BTS of which the BTS of Tajmahal Road is closer to the red circle serving zone than the BTS of Salimullah Road_4. As a result of overshooting, it gave poor RXLevel

Problem: Salimullah Road 1/4 is overshooting at both encircle area of Tajmahal road with poor RXLevel.

Recommendation: Need to change tilt Salimullah road 1/4, from 6 to 7 degree which solve our problem.

3) *Case 03:*

Report type: Traffic Statistic and OMC

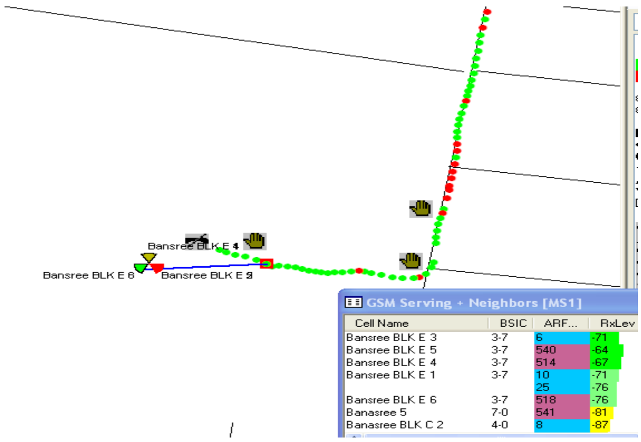

Fig. 4: snapshot of DT

Fig.4 shows that Banasree BLK E3 was serving instead of Bansree BLK E2 though Banasree BLK E2 was near about the serving zone. It didn't give poor RXLevel but it created handover problem. Because of swapping, it messed up with neighbor cell relationship.

In 900 Band, Banasree Blk E 2 & Banasree Blk E 3 are swapped with one another which can be rectified this.

FIG. 5IN 900 BAND BANASREE BLK E 2 & BANASREE BLK E 3 ARE SWAPPED WITH ONE ANOTHER

FIG. 6 TRYING TO FIND OUT IN 900 BAND BANASREE BLK E 2 & BANASREE BLK E 3 SWAPPED CONNECTION

In Fig. 6, we can see a swapping was occurred for wrong connection between feeder cable and combiner port and a faulty connection point of ant2 cable and comber port was seen.

Recommendation: It is offered to change the connection between feeder and combiner and placed ant2 cable to right combiner that was installed for sector 2 and also changed ant3 cable to the combiner, which was installed for sector 3.

Proposal of New BTS Set Up Due to High Congestion

Date: November, 2011

Area: Bogra

Customer complain type: Noise, call dropping continuously, bad sound quality

The software TornedoN – asset module is used for RF Planning. First we have accumulated the KPI data from NSN (Nokia Siemens Network) server which is shown in the table 1. The orange marked regions where this problem occurred are Bogra exchange, Sutrapur, Jalesharitola, Bogra Medical, NuraniMor, Tinmatha, Subgram, Bogra MW.

From the following table I, we can see that the range of traffic of this specific area was (15-30), which is very high. For this reason, handover success rate was very poor (28-70) from the table 1 and the call drop rate was high. From the above KPI data, the range is 25-45.

Through this KPI analysis, we got the reason behind call drop. Call drop rate was high because of high congestion and poor handover success rate. Then a drive test has been attempted in Bogra Staff Quarter for checking the receiving power of signal. We observed that the receiving level of signal in that area is poor. To reduce the congestion and traffic adding TRx of each of these sectors might be solution but setup a new BTS would be better solution to solve this problem.

TABLE I KPI DATA

Region	Traffic	TCH congestion rate	HO Success Rate
Bogra Ex-1	2.34	2.365	92.36
Bogra Ex-1	4.93	2.012	90.36
Bogra Ex-1	3.21	3.123	89.45
Bogra Ex-2	16.63	73.328	49.36
Bogra Ex-2	15.23	68.176	48.62
Bogra Ex-2	23.36	74.04	47.65
Bogra Ex-3	18.34	52.3	68.264
Bogra Ex-3	24.45	51.65	68.576
Bogra Ex-3	24.95	52.97	65.08
Bogra Medical-1	23.56	72.816	52.816
Bogra Medical-1	18.98	74.816	64.816
Bogra Medical-1	24.67	68.164	63.264
Bogra Medical-2	24.56	41.32	69.456
Bogra Medical-2	23.56	50.132	68.465
Bogra Medical-2	23.97	49.698	57.659
Bogra Medical-3	2.032	2.013	97.62
Bogra Medical-3	5.84	7.328	92.653
Bogra Medical-3	4.67	6.264	91.62 s.

Conclusions

Increased services and subscriber numbers are pushing service providers to acquire new planning strategies. The aim of these strategies is to maintain network efficiently. In this paper, it has been analytically proved that we can optimize an existing cellular network using optimization tools and fine parameter tuning. We need some input for planning and optimization we can get these information from traffic statistic, customer complain and drive test. After analyzing all required data we can know what steps we need to do.

Each operator has their own KPI. Operator wants to fulfill their target according to their KPI and they must think about it within their bandwidth limitation. This study would help to plan operators to enhance coverage, improve quality and increase capacity in the days to come. Every mobile operator should give attention towards better network dimensioning & topology, allocated bandwidth, traffic prediction & modeling, network operational expense, and setting fine tuning about network parameter settings during radio network planning. Secondly, operator must ensure better quality of service to customers which compel cellular operators to optimize network performance to meet revenue and commercial targets as well.

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